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The total energy flux leaving the ocean's mixed layer

Antonija Rimac (1,2), Jin-Song von Storch (3), and Carsten Eden (4)

(1) Institute for Marine and Atmospheric Research, Utrecht, Netherlands (a.rimac@uu.nl), (2) Netherlands Earth System Science Centre, (3) Max Planck Institute for Meteorology, (4) University of Hamburg

Interior density mixing contributes to drive the large-scale ocean circulation. The energy needed for this mixing is believed to be supplied predominantly by the tidal and wind forcing. In this study, we focus on the wind-power input to three different types of motions, that is, near-inertial waves, sub-inertial fluctuations, and time-mean flows. Surface winds can generate near-inertial waves which propagate freely into the ocean's interior and after escaping the mixed layer contribute to interior mixing. Winds also input power into the ocean to maintain the time-mean circulation and to generate sub-inertial fluctuations,
either by the vertical or horizontal shear instability of the large-scale flows, or directly via wind induced fluctuations at the ocean surface. The energy of both the sub-inertial
fluctuations and the time-mean flow will be eventually dissipated (or transferred to the internal gravity wave field or small scale turbulence). However, the exact portion of the power that escapes the turbulent mixed layer and that can potentially affect the interior mixing, is still unknown.

The total energy flux leaving the ocean's spatially and seasonally varying mixed layer is estimated using a global 1/10° ocean general circulation model. From the total wind-power input of 3.33 TW into near-inertial waves (0.35 TW) sub-inertial fluctuations (0.87 TW), and the time-mean circulation (2.11 TW), 0.92 TW leave the mixed layer; with 0.04 TW (11.4%) due to near-inertial motions, 0.07 TW (8.3%) due to sub-inertial fluctuations, and 0.81 TW (38.4%) due to time-mean motions. Of the 0.81 TW from the time-mean motions, 0.5 TW result from the projection of the horizontal flux onto the sloped bottom of the mixed layer. This projection is negligible for the transient fluxes. The spatial structure of the vertical flux is determined principally by the wind stress curl. The mean and sub-inertial fluxes leaving the mixed layer are approximately 40-50% smaller than the respective fluxes across the Ekman layer according to the method proposed by Stern (1975). The fraction related to transient fluctuations tends to decrease with increasing depth of the mixed layer and with increasing strength of wind-stress variability.